

# METHOD OF MANUFACTURING UNVULCANIZED ADHESIVE WATERPROOF SHEET AND CONSTRUCTION METHOD USING THE SAME

This application relies for priority upon Korean Patent Application No. 1999-50626,  
5 filed on November 15, 1999, the contents of which are herein incorporated by reference in  
their entirety.

## Field of the Invention

The present invention generally relates to a method<sup>of</sup> manufacturing of an unvulcanized  
10 adhesive waterproof sheet and a construction method using the sheet. Particularly, the present  
invention relates to a method of manufacturing an unvulcanized adhesive waterproof sheet  
for waterproof<sup>ing</sup> of a cut and cover tunnel, an underground structure of a building, and a  
concrete structure such as a building wall and an underground driveway. And, particularly,  
the present invention relates to a construction method using the sheet.

## Background of the Invention

As civil and construction technologies have recently been developed, complex and  
difficult constructions can easily be accomplished. However, defects often occur only in the  
waterproof construction. The defects cause water leakage and submergence. Moreover, the  
15 defects bite and attack a completed structure. Accordingly, a waterproof construction  
becomes important in the civil and construction technologies. In the present time, it is  
desperately required to produce excellent waterproof materials which can exert a continuous  
and perfect waterproof function with only one waterproof construction.

Accordingly, a silicon penetration waterproof agent, a rubberized asphalt sheet, a  
25 water soluble rubberized asphalt paint (aqueous paint film waterproof), a vulcanized rubber  
(boiled rubber) sheet, and an organic solvent rubber paint (oil paint film waterproof) have  
been used.

Since a strength of the cement is improved<sup>ed</sup> over 400kg/cm<sup>2</sup> due to development of the  
construction technology, the penetration waterproof agent is proved to be unsuitable material.

30 The rubberized asphalt sheet is cheap, and exerts a good function in a short time  
because a physical property of the asphalt is waterproofed. Unfortunately, elasticity of the  
rubberized asphalt sheet is reduced as time elapses. Since the sheet is dissolved and vaporized  
at a high temperature (e.g., summer), it becomes hard. And, a volume of the sheet is reduced.  
This results in water leakage and submergence. When the rubberized asphalt sheet attaches to

external walls of a construction structure, humidity or moisture makes it impossible to carry out an attach construction. Although a surface of the external wall is dried well, the sheet partially attaches thereto. Thus, a conventional rubberized asphalt sheet has rarely been used in recent.

5 In the water soluble rubberized asphalt paint, asphalt is mixed and agitated with emulsifier, and latex is added thereto then. Accordingly, a construction of a connecting portion becomes simple. However, since a main material of the paint is asphalt, it has the same drawbacks as the foregoing rubberized asphalt sheet. Moreover, the liquid asphalt paint is vulnerable to a concave-convex structure (i.e., it is impossible to form a waterproof film  
10 having a constant thickness).

The vulcanized rubber sheet is boiled in a manufacturing process, and has elasticity, tension, and tensile force that are original properties of rubber. Accordingly, the vulcanized rubber sheet is good for shake resistance, shock resistance, and chemical resistance. In addition, physical property and waterproof function thereof is excellent. The vulcanized  
15 rubber sheet, however, has difficulties in entirely attaching to external walls of a structure and performing construction of a connecting portion. This results in water leakage and deterioration of the waterproof function.

In order to remedy drawbacks of the above-mentioned waterproof materials, the organic solvent rubber paint is developed which uses rubber as a main material. The rubber is  
20 resolved in a volatile solvent such as toluene and thinner using a liquid agitator, manufacturing the organic solvent rubber paint. Compared with the vulcanized rubber sheet, the paint makes it simple to perform the construction of the connecting portion. When a solvent is dried, the paint is changed to a rubber sheet. Therefore, the organic solvent rubber paint is a good waterproof agent. However, elasticity, peel strength, and tensile force of the  
25 paint are lower than those of a vulcanized rubber because the manufactured rubber sheet is situated in an unvulcanized rubber gray state. If a paint film waterproof agent using an oil rubber as a main material is coated once, a rubber film is formed after drying a solvent. At this time, the rubber film is shrunken and a thickness thereof is reduced to 0.2mm-0.4mm. In order to form a waterproof film having a constant thickness (1mm-2mm), the waterproof  
30 agent should repeatedly be coated. Since the waterproof agent is coated once and left for 5-6 hours so as to dry the solvent, soil or dust is fixed to a coating surface. Therefore, the waterproof film is divided into a plurality of films. Further, air bubble or air pocket is considerably created.

Although concrete used in civil and construction structures is dried well, it generally contains moisture of 10%-20%. In most case, concrete used in an underground structure contains moisture of 80%-90%. As mentioned above, a moisture content of the conventional waterproof agents is high. Therefore, the agents cannot attach to the concrete. Although a waterproof agent forcibly attaches to concrete using a lamp or a burner, a waterproof construction is still unstable and defects are created in the construction.

In order to prevent damage of the waterproof film, the conventional waterproof agents must use a waterproof film protectant such as an EVA (ethylene vinyl acetate) bubbling sheet or a PE (polyethylene) fibrous sheet. However, the protectant is forced out or damaged and the waterproof film is attacked in a refilling process. Unfortunately, the protectant causes the defects. On the other hand, in order to protect the waterproof film, bricks are laid to form a wall, and then a refilling process is carried out. Such a manner delays a term of works and requires excessive cost.

#### Summary of the Invention

It is therefore an object of the invention to provide a method of manufacturing an unvulcanized adhesive waterproof sheet and a construction method using the sheet which can simply perform a waterproof construction of a civil structure or a construction structure, and maintain a waterproof function for a long time.

It is another object of the invention to a method of manufacturing an unvulcanized adhesive waterproof sheet and a construction method using the sheet which can easily and stably perform a waterproof construction to a surface containing humidity or moisture.

According to an aspect of the invention, a method of manufacturing an unvulcanized adhesive waterproof sheet comprises the steps of agitating a rubber main material composed of at one of a natural rubber and a synthetic rubber with a vulcanizing compound agent, an age resister, an adhesion-providing agent, a softener, and a filler, and then adding and agitating a vulcanizing agent thereto in an open roller, thereby producing a raw rubber material; rolling and forcing out the raw rubber material with constant width and thickness, thereby manufacturing a waterproof sheet; and making a releasing paper attach to both surfaces of the waterproof sheet, being cut with a constant length.

~~The age resister includes at least one selected from a group consisting of phenylisopropyl-p-phenylenediamin, polymerized trimethyl dihydroquinoline, and styremeated phenol. The adhesion-providing agent includes at least one of tragacanth rubber and polyvinyl poval (PVA) that is affined with water.~~

According to another aspect of the invention, there is a construction method using the unvulcanized adhesive waterproof sheet. One surface of the waterproof sheet attaches to a surface of a structure surface. The other surface thereof attaches to wet mortar with a constant thickness. At this time, the waterproof sheet is turned into a vulcanized rubber so as to achieve waterproof of the structure after the construction.

Before waterproof sheet attaches to the surface, premier which is produced by resolving the raw rubber material in organic solvent is coated on the structure surface. When the waterproof sheet attaches to the surface, the waterproof sheet and the structure surface are coupled and overlapped with each other. Then, the overlapped portion adheres using the premier. Before the waterproof sheet attaches to the surface, a portion of water leakage which is caused by cracks of the structure surface is closed using an adhesion agent produced by resolving the raw rubber material in a constant amount of organic solvent. After the cracks are closed using the adhesion agent, the premier is coated on the surface.

#### Description of the Preferred Embodiment

In functions, a waterproof agent made of asphalt is superior to that made of rubber. Accordingly, the inventor of this invention thinks that a perfect waterproof sheet must have conditions as follows. First, a rubber film has a constant thickness. Second, connection parts are monolithically and easily coupled to each other, and perfectly attach to each other. Third, a waterproof construction is performed using a vulcanized rubber sheet having good elasticity, tension, and tensile force that are intrinsic properties of a rubber. In view of such facts, the inventor previously got patents using an unvulcanized adhesive waterproof sheet using rubber as a main material (Korean Patent Application No. 95-5008 entitled "MANUFACTURING METHOD OF UNVULCANIZED ADHESIVE WATERPROOF SHEET AND CONSTRUCTION METHOD THEREOF" and Korean Patent Application No. 96-37884 entitled "METHOD OF MANUFACTURING UNVULCANIZED ADHESIVE WATERPROOF SHEET").

In these patents, an adhesive gray-state unvulcanized waterproof sheet adding a vulcanized agent is manufactured with constant width and thickness. Accordingly, in a construction using the sheet, a construction thickness is constant and connecting parts are monolithically attaches to each other. This makes it possible to construct even a wide area using a piece of rubber sheet. The sheet is second-activated at ordinary temperature, being turned into a vulcanized rubber sheet. Tension and tensile force of the sheet can fill concrete cracks due to suture thereof. As a result, the sheet provides a perfect water-stopping effect.

However, the adhesive gray-state unvulcanized waterproof sheet adding a vulcanized agent must suffer from an aging phenomenon. For example, when the sheet is exposed to sunshine, rain, and wind on a rooftop of a building for three or four months, cracks are created on a surface of the sheet. Therefore, the present invention provides a new and improved manufacturing method of an unvulcanized adhesive waterproof sheet and a waterproof construction thereof, with repetitive test and study.

The waterproof construction of this invention is performed through the following steps. Primer that is produced by resolving a raw material of rubber in a constant amount of organic solvent is coated. The unvulcanized rubber sheet attaches. Wet cement mortar, which is kneaded with water, attaches for protecting an attaching waterproof film. The mortar is hardened and cured. Finally, a refilling process is performed. After the waterproof construction is finished, the sheet is activated to be a molding vulcanized rubber with time. More specifically, primer is coated on a cut and cover tunnel, an underground structure of a building, and a building wall. With an adhesive unvulcanized rubber sheet of an adhesive rubber gray state, an attaching construction is monolithically performed without an expansion opening. Wet mortar kneaded with water attaches onto a surface of the attaching waterproof sheet. Moisture of the wet mortar is dried and cured. Since the mortar and adhesive unvulcanized rubber have adhesion then, they strongly attach. The unvulcanized rubber sheet is second-activated at ordinary temperature, being turned into a molding vulcanized rubber sheet. And then, the molding vulcanized rubber sheet is turned into a rubber sheet having elasticity, tension, and tensile force that are intrinsic properties of the rubber, exerting a perfect waterproof construction effect. Using the molded and vulcanized rubber sheet as a medium, both walls attach to each other by concrete. Therefore, it is possible to perform a waterproof construction without defects.

An unvulcanized adhesive waterproof sheet of this invention is produced by adding a rubber material composed of at least one of natural rubber and synthetic rubber to a vulcanizing agent, an age resister, an adhesion-providing agent, a softener, a filler, and a vulcanizing agent. Such agents are added to natural rubber or synthetic rubber or combination thereof or a combined rubber produced by adding rubber powder or recycled rubber to the natural rubber or the synthetic rubber. The agents and one of the rubbers are then mixed and agitated in a closed mixer (e.g., kneader or bumberey), being evenly distributed. And then, the agitation is performed in an open roller, with adding the vulcanizing agent. The agitated raw material of the adhesive rubber is rolled in a calender, having a constant width and a thickness of 1mm-5mm. The rolled material is fetched to the sheet, and then is cut with a

constant thickness. Finally, the rolled and fetched rubber sheet is rolled up, with silicon-coated releasing paper attaching to both surfaces thereof.

5 ~~The unvulcanized adhesive rubber sheet is used for unexposure. Durability of the~~  
sheet is over the warranty (five years). In order to maintain a waterproof function for a long  
time, it is required to add a special age resister to the sheet. Therefore, the present invention  
uses age resisters, "3C" (Phenylisopropyl-p-phenylenediamin), "RD" (Polymerized trimethyl  
dihydroquinoline), and "SP" (Styrenated phenol). The "3C" is good for heat resistance,  
flexure-crack resistance, oxidation resistance, and ozone resistance. The "RD" is good for  
heat resistance and oxidation resistance. And, the "SP" is good for flexure resistance,  
10 oxidation resistance, and ozone resistance. Adding such age resisters to the sheet, the sheet  
maintains an initial state for a long time. When the sheet attaching to a wall of a rooftop is  
left for two years (two summers and winters), cracks or rips are not created on a surface of  
the sheet. In case of an unexposure construction, the sheet exerts an excellent waterproof  
function for a long time.

15 Generally, a waterproof construction is performed to an external wall of a structure.  
Accordingly, the construction is performed to an external wall of concrete using a waterproof  
material. In order to protect the waterproof material, an EVA blowing sheet or PE fibrous  
sheet is applied to an outside of the waterproof material. However, the EVA blowing sheet or  
PE fibrous sheet is difficult in attaching to a corner or a flexure, and incompletely attach to  
20 the waterproof material. In a refilling process, a protectant is forced out or damaged and a  
waterproof film is attacked. Unfortunately, the protectant causes defects. Instead of EVA  
blowing sheet and PE fiber, cement mortar is used as a waterproof protectant so as to solve  
such defects and protect a waterproof film. Therefore, a corner or a complex flexure can  
simply be constructed. Using a waterproof sheet as a medium, an inside adheres to an outside  
25 by concrete, being closed to achieve a perfect waterproof construction.

30 In order to use mortar as a waterproof film protectant, the unvulcanized adhesive  
waterproof sheet adds Tragacanth Gum and PVA (polyvinyl Poval) resin to the adhesion-  
providing agent. The Tragacanth Gum and PVA resin is affined with water and is compatible  
with other material, being mixed well. The sheet containing an adhesion-providing agent and  
the raw rubber material are resolved in a constant amount of organic solvent, forming premier  
which enables the sheet to perfectly attach to a structure surface containing humidity or  
moisture. Even though an underground structure contains moisture 80%-90%, the sheet can  
eminently attach thereto. According to an experimental result of the inventor, when the  
premier is coated on a brick or a concrete piece with gathered water and the unvulcanized

adhesive rubber sheet adheres thereto, the adhesion becomes strong. Since a surface of a structure in a work site has poor adherence conditions, the primer is used for enabling an unvulcanized adhesive waterproof sheet to attach to a structure surface. And, the primer is used at an overlap portion of waterproof sheets.

In order to overcome conventional problems (exfoliation, cement exclusion, crack, etc.), the premier is coated on an external surface of concrete and the unvulcanized adhesive rubber sheet adheres thereon. Then, wet mortar kneaded with water attaches to a surface of the sheet. If the water is dried and adhesion is created in curing the cement mortar, a waterproof film and the cement mortar strongly attach to each other. The sheet attaching in the mortar can absorb external impact and suppress creation of cracks.

On the other hand, the construction method using the unvulcanized adhesive waterproof sheet utilizes putty that is produced by resolving a raw rubber material in organic solvent such as toluene. The putty closes a portion of water leakage caused by cracks of a structure surface. Using the putty, the cracks are closed. If the premier is then coated on the structure surface repeatedly and the sheet attaches thereon, the more perfect construction will be achieved.

In view of the cost, a waterproof construction method using an unvulcanized adhesive waterproof sheet is cheaper than a conventional method using an EVA blowing sheet and a PE fibrous sheet or a bricklaying method. And, such a waterproof construction method can solve conventional difficulties (e.g., a waterproof construction cannot be performed to a wet mortar kneaded in water as well as a structure surface having humidity or moisture, and the construction is forcibly performed to create defects).

#### <Preferred Embodiment>

An unvulcanized adhesive waterproof sheet of this invention is composed of composites having a mixture ratio, as follows.

<div style="position: absolute; left: -50px; top: 50px; transform: rotate(-45deg); font-weight: bold;">Sub 23</div> <div>Rubber Main Material</div>	One of Natural rubber and Synthetic rubber (SBR rubber, 1R rubber, EPT rubber, 2R rubber, CR rubber, NBR rubber, Urethane rubber, and CPE rubber) or Combination thereof	100%
	Stealic Acid	1%
	Magnesium Oxide	5%
	Zinc Oxide	5%
<div style="display: flex; justify-content: space-between;"> <div>MJ&amp;M Doc. No.: 4234-9</div> <div>7</div> </div>		

Sub 237

	Sulfur	2%
Age Resister	Age Resister 3C (Phenylisopropyl-p-phenylenediamin)	2%
	Age Resister RD (Polymerized trimethyl dihydroquinoline)	1.5%
	Age Resister SP (Styrene-treated phenol)	2%
Adhesion-providing Agent	Polybutene	6%
	Phenol-Formaldehyde-Resin	8%
	Petroleum Resin	10%
	PVA (Polyvinyl alcohol)	12%
	Tragacanth Gum	5%
Softener	Process Oil	14%
Filler	Calcium Carbonate	40%
	Clay	15%
Vulcanizing Agent	DM	1.6%
	D	1%
	T/T	1%
	NA22	1%

Intrinsic physical properties and characteristics of the rubber compound materials are different from each other. Therefore, based on usage of a waterproof sheet or requisition of a user, only one of the natural and synthetic rubbers or combination thereof may be used.

- 5 Alternatively, two and more kinds of synthetic rubbers may be used. For example, a CR rubber main material has the best properties such as adhesion, durability, and chemical resistance.

10 The age resisters (3C, RD, and SP) are added to an unvulcanized adhesive waterproof sheet, improving durability. In order to maintain strong adhesion between composites of the sheet and provide adhesiveness, the adhesion-providing agents (polybutene, phenol-formaldehyde-resin, and petroleum resin) are added thereto. And, in order to provide adhesion and adhesiveness to wet mortar kneaded with water and a structure having humidity and moisture, the tragacanth gum and the PVC resin which are compatible with other composites are added thereto. Since there are synergy and compatibility between a resin of an



adhesion-providing agent and a water-compatible resin, adhesion and adhesiveness can be improved. And, a waterproof construction can smoothly be performed at dry and wet portions.

A method of manufacturing an unvulcanized adhesive waterproof sheet is composed of the following steps. One of natural and synthetic rubbers (SBR rubber, 1R rubber, EPT rubber, 2R rubber, CR rubber, NBR rubber, Urethane rubber, and CPE rubber) or combination (100%) thereof is fully agitated in a closed mixture agitator "Kneader Mixer" or "Bandury Mixer". The vulcanizing compound agents, stearic acid (1%), magnesium oxide (5%), zinc oxide (5%), and sulfur (2%) are evenly mixed therewith. The age resisters, 3C (2%), RD (1.5%), and SP (2%) are then agitated, being mixed and distributed evenly. Then, the adhesion-providing agents, polybutene (6%), phenol-formaldehyde-resin (8%), petroleum resin (10%), tragacanth gum (5%), and PVA (12%) are fully mixed and agitated therein. And then, the softener, process oil (14%) as well as the filler, calcium carbonate (40%) and clay (15%) are fully mixed and agitated therewith. With adhesive unvulcanized raw rubber material agitated in a roller, vulcanizing agents, DM (1.5%), D (1%), T/T (1%), and NA22 (1%) are added, being distributed and mixed evenly. In calender machine, the sheet is rolled and forced out with a constant width and a thickness of 1mm-5mm. Finally, the sheet adheres to releasing paper of a high-density film (HD), polypropylene (PP), and polyethylene (PE), being rolled up and cut with a constant length. The releasing paper of the rolled waterproof sheet must be uncovered in a waterproof construction. To be used as a material of the releasing paper, silicon is coated on both surfaces of a synthetic resin film such as HD, PP, and PE.

Since the unvulcanized adhesive waterproof sheet has adhesion therein, its adhesion to concrete is excellent. However, a surface of a construction structure in a work site is generally contaminated by cement powder, soil, dust, and filth. Accordingly, the waterproof construction method utilizes premier (viscosity, 500-600) that are produced by resolving the raw rubber material (weight, 50) in toluene (weight, 150). That is, the premier is rendered on a concrete surface and the unvulcanized waterproof sheet attaches thereto, achieving a stronger adhere construction. Similarly, a coupling portion more strongly adheres by means of the premier.

In comparison with a conventional method, the present invention makes it possible to simply coat the premier on a structure using a brush. The premier can strongly be coated on even metal or rusted iron, so that the unvulcanized waterproof sheet simply and strongly attaches thereto.

In case of water leakage caused by cracks of a structure surface, an adhesion agent (viscosity, 1500-1700) that is produced by resolving the raw rubber material (weight, 500) in toluene (weight, 70) is utilized. After the cracks are closed using the adhesion agent, the water leakage is stopped and the premier is coated thereon. After solvent is dried and a premier film is formed, the premier recoated thereon. A rubber sheet strongly attaches to the premier then, so that adhesion is achieved.

In the waterproof construction method, the unvulcanized adhesive waterproof sheet attaches to a structure surface. Mortar of 10mm-20mm then attaches to a surface of the waterproof sheet. The more a cement component contained in mortar is, the better adhesion is. Accordingly, a quality of the mortar is at least higher than that of standard mortar (cement 1 : sand 2.5). Moisture of the attaching cement mortar is vaporized to create adhesion. After five or seven days, the mortar is cured to have strong adhesion. The attaching mortar having the strong adhesion can resist external impact (i.e., overcome exfoliation, evasion, breakage, and cracks). Using the unvulcanized adhesive waterproof sheet as a medium, internal and external walls completely attach to each other. Thus, defects cannot occur.

In a waterproof construction to an external wall of a building, the premier is coated on the external wall to form a rubber film. Mortar kneaded with water attaches to a surface of the rubber film, being cured. Sidewalls are refilled with a good quality of earth and sand. Then, water is sprayed to harden the earth and sand. An underground parking lot or a rooftop is subject to a mortar (thickness, 2cm-3cm) construction, and is refilled with the same manner. So the waterproof construction is finished. At ordinary temperature, the unvulcanized adhesive waterproof sheet is second-activated, being turned into a vulcanized rubber with time (1-2 months in summer, 2-3 months in winter). Therefore, the waterproof sheet has high tension and tensile force, and maintains a waterproof function. Further, heat resistance, cold resistance, and chemical resistance of the waterproof sheet is so good that the waterproof sheet can exert good physical properties in a severe condition. As a result, the waterproof sheet can maintain a waterproof function until a civil and construction building is deconstructed.

In the drawings and specification, there have been disclosed typical preferred embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purpose of limitation, the scope of the invention being set forth in the following claims.